



Method of forming a Seal Pattern for Liquid Crystal Display Device

Cross Reference

This application claims the benefit of Korean Patent Application No.1999-0036786, filed on September 1, 1999, under 35 U.S.C.§119, the entirety of which is
5 hereby incorporated by reference.

Background of the invention

Field of the invention

The present invention relates to a seal pattern used in a liquid crystal display
10 (LCD) device..

Description of Related Art

A typical LCD device comprises a LCD panel having upper and lower substrates that are spaced apart from and opposed to each other, and an interposed liquid
15 crystal layer. The upper substrate includes a common electrode, and the lower substrate includes switching elements, such as thin film transistors (TFTs), and pixel electrodes.

As a brief explanation about the manufacturing process of a liquid crystal cell of a liquid crystal panel, the common electrode and the pixel electrodes are respectively formed over the upper and lower substrates. A seal pattern is formed over the lower
20 substrate, and then the upper and lower substrates are aligned and spaced apart from each other so that the common electrode of the upper substrate and the pixel electrodes of the lower substrate are opposed. A liquid crystal is then injected into the gap between the upper and lower substrates through an injection hole. The injection hole is then sealed, and finally, polarizing films are attached to the outer surfaces of the upper and
25 lower substrates.

In operation, the amount of light passing through a liquid crystal cell is controlled by an electric field formed by the pixel and common electrodes such that

characters or images are produced due to a light shutter effect.

The liquid crystal cell manufacturing process has few repeated steps. The overall process is divided into an orientation film forming process, a cell gap forming process, and a cell cutting process that produces cells of a desired size.

5 Referring now to FIG. 1, a typical liquid crystal cell manufacturing process will be explained in detail.

As shown in FIG. 1, the first step is to form an array of thin film transistors and corresponding pixel electrodes on the lower substrate.

10 The second step is to form an orientation film over the lower substrate by uniformly depositing a polymer thin film on the lower substrate, and then uniformly rubbing the polymer thin film with a fabric.

The rubbing process is performed by rubbing the surface of the polymer thin film in a proper direction with the fabric so as to establish the orientation direction of the liquid crystal. A typical orientation film uses an organic thin film, such as a
15 polyimide thin film.

The third step is to print the seal pattern over the upper substrate.

Due to the seal pattern, after attaching the upper and lower substrates, a space for interposing the liquid crystal is formed. The seal pattern also ensures that the interposed liquid crystal doesn't leak out of the liquid crystal cell. A thermosetting
20 plastic and a screen-print technology are conventionally used for the seal pattern.

The fourth step is to scatter spacers over the lower substrate.

The spacers have a definite size and maintain a precise and uniform spacing between the upper and lower substrates. Accordingly, the spacers are scattered throughout the lower substrate at a uniform density via either a wet spray method of

spraying spacers mixed with an alcohol, or a dry spray method of spraying only the spacers.

Further, the dry spray method is divided into a static electric spray method that uses static electricity, and a non-electric spray method that uses gas pressure. Since
5 static electricity is detrimental to the liquid crystal, the non-electric spray method is widely used.

After scattering spacers, in the fifth step, the upper substrate having color filters and the lower substrate having the thin film transistor array are aligned and attached to each other.

10 An aligning margin, which is less than a few micrometers, has an important role in the aligning and assembling process. If the two substrates are aligned and attached beyond the aligning margin, light leaks away such that the liquid crystal cell doesn't have a desired display quality.

In the sixth step, the liquid crystal cell fabricated through steps 1 to 5 is cut into
15 unit cells. Conventionally, the liquid crystal is injected into the spacing between the upper and lower substrates, and then the liquid crystal cell is cut into a plurality of unit cells. But for larger displays, the liquid crystal cell is cut into unit cells before the liquid crystal is interposed. After cutting, the liquid crystal then is injected into the individual unit cells.

20 The process of cutting comprises a scribing process of marking lines on the substrate using a diamond pen, which is harder than the glass substrate, and then a breaking process of cutting the substrate using force (or pressure) along the marked lines.

The seventh step is injecting the liquid crystal into the unit cell.

Since a unit cell has a few square centimeter surface area and only a few micrometer gap, a vacuum injection process of injecting the liquid crystal that uses a pressure difference is effectively and widely used.

Now, referring to Fig. 2, a screen-print method for applying the seal pattern
5 according to the third step is explained in more detail.

The screen-print method is facilitated using a patterned screen 6 and a squeegee 8.

To interpose the liquid crystal without leakage, the seal pattern 2 is formed along the substrate 1 near the edges, and an injection hole 4 for injecting the liquid
10 crystal is formed.

To form the seal pattern 2, a thermosetting plastic having embedded spacers to maintain the gap between the two substrates is distributed on the substrate 1. Thereafter, a solvent in the sealant is evaporated, leaving a level surface.

In forming the seal pattern, the uniformity in thickness and in width of the
15 sealant is very important to maintain a uniform spacing (or gap) between the two substrates.

For the seal pattern 2, a thermosetting or an ultraviolet-setting epoxy resin or the like is conventionally employed. But, though the epoxy resin itself is not harmful to the liquid crystal, an amine in a thermohardening solvent decomposes the liquid crystal.
20 Thus, when using an epoxy resin for the seal pattern 2, the sealant formed through the screen-print method is pre-baked using a gradual change of baking temperature.

Hereinafter, referring to Fig. 3, the seal pattern itself is explained in detail.

Conventionally, to supply an electric field for the liquid crystal, electrode pads are formed over the lower substrate. A voltage is then supplied to the common electrode

of the upper substrate by way of the electrode pads using electric conductors formed on the lower substrate. For the electric conductors, a silver paste (hereinafter referred to as a silver dot 10) is usually used.

As shown in Fig. 3, the silver dot 10 is formed outside of the seal pattern with respect to the display area A. Namely, the seal pattern 2 is formed along and on the substrate, but near the silver dot 10, and the seal pattern forms a rectangular shape to bypass the silver dot 10. Around the silver dot 10, the seal pattern 2 protrudes inward a length L. Light spots can occur in the display area A of the liquid crystal display device due to the amine included in the seal pattern 2.

Though the above-mentioned screen-print method is widely used due its convenience, the screen-print method can produce errors as a result of the contact between the screen and the orientation film formed over the substrate. Additionally, the screen-print method is not easily adopted to larger substrates.

Further, in the screen-print method, after the sealant is formed on the whole patterned screen, the squeegee rubs the sealant to form the seal pattern. Since the sealant is formed throughout the patterned screen, part of the sealant is wasted.

To overcome the above-mentioned problems, a dispenser-print method has gradually been adopted.

Referring to Fig. 4, in the dispenser-print method, a dispenser 20 is filled with the sealant. A substrate 1 is then located on a table. The dispenser 20 then moves over the table 100 as the dispenser dispenses sealant in the sealant pattern 2.

However, the dispenser-print method has poor quality when dispensing along a complex pattern. Therefore, the seal pattern 2 shown in Fig. 3 is difficult to reliably produce using the dispenser-print method.

SUMMARY OF THE INVENTION

In view of the foregoing and other problems, it is an object of the present invention to provide for small-bend seal patterns that decrease light spots in the display area of liquid crystal display devices.

Another object is to provide a small-bend seal pattern that is suitable for use with the dispenser-print technology.

Thus, to overcome the above-mentioned objects, the present invention provides a method of forming a seal pattern for a liquid crystal display panel having a liquid crystal layer. That method comprises forming a common electrode on a first substrate; forming a plurality of conductive contact dots on the second substrate; forming a seal pattern along edges of the second substrate, wherein the seal pattern includes a plurality of triangular bent portions which are bent toward the inside of the second substrate; joining the substrates; and injecting the liquid crystal layer between first and second substrates.

The foregoing and other objectives of the present invention will become more apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications that are within the spirit and scope of the invention will become apparent to those skilled in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages

thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which like reference numerals denote like parts, and in which:

Fig. 1 is a block diagram illustrating a typical manufacturing process for a
5 liquid crystal cell;

Fig. 2 is a perspective view illustrating a seal pattern process with a screen-print method;

Fig. 3 is a plan view illustrating a seal pattern around a silver dot;

Fig. 4 is a perspective view illustrating a dispenser-print method for a seal
10 pattern;

Fig. 5 is an expanded plan view of "r1" of Fig. 6;

Fig. 6 is a plan view illustrating a seal pattern around a silver dot according to a first embodiment of the present invention; and

Fig. 7 is a plan view illustrating a seal pattern around the silver dot according
15 to a second embodiment of the present invention.

DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENTS

Referring now to the drawings, and more particularly to Fig. 6, a first embodiment of the present invention will now be described.

20 Fig. 6 illustrates features of a seal pattern 200 according to the first embodiment of the present invention.

As shown in Fig. 6, around a silver dot 10, the seal pattern 200 has an open-sided triangular bent portion that bypasses and surrounds the silver dot 10 with a vertex that is opposite to the open-side. The vertex is protruded toward a display area "A". The

triangular shape of the seal pattern 200 decreases the area of the protruding portion of the seal pattern in comparison with the rectangular bend of the conventional seal pattern.

Further, the triangular shape of the seal pattern 200 decreases the number of
5 bends so that the dispenser-print method is better able to print the seal pattern.

In the seal pattern 200 according to the first embodiment of the present invention, the triangular bend has a first vertex "r1", a second vertex "r2", and a third vertex "r3" that are all rounded, as will be explained with the assistance of Fig. 5. Otherwise, at the vertexes in the seal pattern, cuttings or line-opens can occur during the
10 dispenser printing.

More specifically, the distance "d" between the silver dot 10 and the third vertex "r3" is preferably 0.1 to 1 millimeters(mm); the distance "l" between the first and the second vertexes "r1" and "r2" is preferably 5 to 20 mm.

Fig. 5 illustrates an expansion of the first vertex "r1" having a turning radius
15 "R". The turning radius "R" of vertex "r1" is preferably 0.5 to 5 mm. The turning radius in the first vertex "r1" is also that of the second and third vertexes. Namely, the second and third vertexes also have the same roundness.

However, the seal pattern according to the first embodiment of the present invention is not limited to the structure of the above-described triangular bend.

20 That is to say, referring to Fig. 7, as a modification of the first embodiment of the present invention, instead of the triangular bent portion, the seal pattern 200 has a circular or an elliptical bent portion that surrounds the silver dot 10 and that has two rounded vertexes "r1" and "r2". The turning radius of the rounded vertexes "r1" and "r2" is also beneficially 0.5 to 5 mm like the vertexes of the triangular bent portion.

As described above with reference to Figs 5 to 7, the triangular, circular, or elliptical bend of the seal pattern 200 according to the preferred embodiment decreases the display-area-penetrating portion of the seal pattern so as to minimize light spots on the display area around the silver dots.

5 Further, in comparison with the conventional rectangular bent portion, due to the decrease of the number and angles of bent points in the bent portions such as the vertexes, the dispenser-print method can be used to apply the seal pattern without denigration of printing quality.

10 While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.